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WHITEWATER RESCUE INSTITUTE

Swiftwater Rescue

First Edition

Cody Harris
Mike Johnston

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First Edition

Cody Harris
Mike Johnston

Lolo, Montana
www.whitewaterrescue.com

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First Edition

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In memory of Justin P. Brindley
(1978-2008)

"Do not go where the path may lead;
go instead where there is no path and
leave a trail."
Ralph Waldo Emerson

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The Whitewater Rescue Institute

The Whitewater Rescue Institute is dedicated to providing the highest quality education for our students. We have provided river rescue instruction to staff from over 200 different companies and rescue agencies. Clients include the U.S. Forest Service, the Discovery Channel, the National Park Service, U.S. Coast Guard, World Class Kayak Academy, Montana River Guides, Wild River Adventures, Geyser Whitewater Expeditions, Montana Yellowstone Expeditions, Montana Fish, Wildlife, and Parks, and fire departments across the Northwest.

This manual is designed to serve as a complement for WRI swiftwater rescue courses. It should not be used as a substitute for swiftwater training. It is not a complete guide to swiftwater rescue.

As this manual is a tool so too, is every rescuer's judgment. The techniques described in this manual and the swiftwater course are meant to be practiced in a controlled environment before they are put into use in the field. There is no guarantee that they will work in every situation. The ultimate decision and responsibility lies in the rescuer's hands. The Whitewater Rescue Institute and the authors do not assume responsibility for any injury or death caused by the use or misuse of any information contained in this manual.

Introduction:
A Lost Companion

Justin P. Brindley drowned on the Colorado River on June 20, 2008. His story, told below, is a story we can all learn from. Our intention is not to place blame, but rather to examine the circumstances surrounding Justin's tragic death and hopefully to prevent future accidents.

By now the flowers have wilted, and perhaps floated away —downstream—mingling with the rocks and sand of the high Rockies. They were temporary, not meant to last. We put them there to remember Justin.

We had walked upriver, from Radium, not twenty-four hours after Justin had been there. Not twenty-four hours after Justin had left that place, and the world. The three of us walked in silence, not knowing the words that fit with our thoughts. We went to the Colorado looking for answers, and hoping for some semblance of meaning from this tragedy.

The construction of the railroad, years before, had left the river right shore littered with a cobble of sharp granite. At the rapid called Eye of the Needle, the river is constricted between the railroad slag and a cliff on the left bank. At the top of the rapid, dead center, sits a rock. For a boat, there are two choices—go left or go right. Both channels have sufficient flow. The rapid is sandwiched by large flatwater pools. By anyone's standards, Eye of the Needle on the Upper Colorado is a straightforward rapid.

Justin was in an inflatable kayak on June 20, 2008. He had his dog Cassius and a weekend's supply of gear: sleeping bag, pad, tent, and food. With him was a group of thirty, celebrating the end of the spring semester at CU Boulder. Justin had more to celebrate. He had just turned thirty, was engaged, and had his wedding invitations in the mail. Justin had also finished three years of school and now had his MBA. Everything was ahead of him.

I try to imagine how he felt. The excitement of a new river and new friends. The scenery spectacular. High mountains in the distance, aspen-fringed meadows descending rapidly to the river, the deepening gorge of Lower Gore Canyon. The smell of earth in the gurgling waters. The birthplace of the Colorado just a few miles to the north. I can see him smiling. A river trip!

The river was busy that day. Boat after boat came through Eye of the Needle. Some fumbled, others had no problems. As Justin approached, I am certain he felt the quickening awareness of a rapid unrun.

Justin flipped as his ducky hit the rock and slid off the left side of the rock. He was first in his group. One friend saw him reflip his boat. Thinking he was okay, the decision was made to go after the dog. The next person that came through saw Justin on the right bank. They exchanged a few words, made a joke, and assumed everything would be fine. This would not be the case. This was the last time he was seen alive.

The remaining boats came through the rapid—not one had seen Justin. Thinking he hiked downstream unnoticed, the group decided to find his boat. They left Eye of the Needle and floated downstream. His boat was on shore, half a mile away, put there by a kayaker from another group. They waited. They talked and laughed. And still, no Justin. They were not worried. This was a float trip. Class II. No need to worry. Justin would show up shortly, they thought.

Finally, on the railroad tracks, they saw someone walking towards them. Thinking it was him, everyone continued downstream—save one. Justin should have no problem getting back to his boat.

The person was not Justin.

An alarm went off—where was he? That alarm, though, only sounded in one person's mind. Everyone else had left. With an increasing sense of urgency, this person ran back upstream. Something was wrong.

He did not find Justin. Another group did.

They pulled him out of the water. His body was battered. He was not breathing, and he had no pulse. They began CPR. Someone went to call for help. They continued CPR as they

floated to the take-out. They passed the rest of Justin's group and told them.

They got to the take-out just as the ambulance arrived. Despite these heroic efforts to save him, Justin was pronounced dead at Saint Anthony's Hospital in Denver.

No one saw what happened to Justin. He was on shore and seemed to be fine. He was surrounded by tame waters—the worst of what there was was upstream. Somehow Justin drowned. Perhaps he slipped, hit his head, and rolled into the river. Maybe he had hit his head when his boat flipped, and slowly went unresponsive. We will never know. What we do know is that he is gone.

Justin's story is a tragedy. Everything was working against him that day. He had run out of luck. With hindsight, it seems so simple to fix. If his group had stayed together and helped him, we might be laughing about it. Or if one of the other groups that passed by and saw Justin on shore had stopped to help, he might still be alive. But that is not the case. So we must do the only option left to us—learn and prevent this from ever happening again.

By taking the steps to become a swiftwater rescue technician, you are well on your way to this goal. The purpose of this training is not to have you walk away feeling like an expert. In fact, we at the Whitewater Rescue Institute do not feel that there is such a thing as a swiftwater expert. The river is a dynamic environment where a simple mistake can easily snowball into an unbelievable disaster.

This training in swiftwater rescue will provide you with the knowledge to recognize and avoid obvious hazards. It will stress the importance of maintaining a heightened level of awareness and always looking downstream, ready for the worst possible event to happen. It will focus on effective techniques to set up safety to prevent accidents. And it will show you ways to keep your boating partners and rescue team safe when out on the river.

Thank you for taking the steps towards preventing future tragedies. Lets get on the river for Justin!

The WRI Approach to Rescue Training

We want this course to be the best whitewater rescue and river safety training possible. Awareness is a key concept for WRI training. On one level, we would like you to be able to recognize and avoid potential hazards on the river. On another level, we'd like you to develop an awareness of the potential for a myriad of things to go wrong during a rescue attempt, so that you are always in a preventative mindset and, that if an emergency does occur, you will not become a victim.

1. **Practice Heightened Awareness**. See things that could happen before they do. Ask yourself "What if" to develop a preventative mindset.
2. **Your Priority: Don't Become a Victim**. "A successful rescue attempt is one in which nobody gets hurt."
3. **Learn by Doing**. Hands-on training in appropriate conditions can teach us what does and does not work.

Our Goals for a WRI Class

1. To develop a set of tools and skills to deal with a variety of river rescue situations such as: conscious and unconscious swimmers, stranded victims, entrapment situations, multiple victims, and pinned boats.

2. More importantly to develop, through the hands-on training, a heightened level of awareness in order to prevent accidents.

Course Expectations and Student Participation

The more you are ready to participate in the drills and scenarios during the class, the more you will learn from the experience. On the other hand, if there are elements of the class you are uncomfortable with, please do not do anything you feel is unsafe or well beyond your comfort zone. Swiftwater rescue is a relatively new discipline, and we encourage students to share personal insights, information, or experiences with the class. Take advantage of the opportunity to learn from other students as well. Be wary of the rescuer who thinks he or she cannot learn something from anyone else. We often create rescue teams combining less experienced students with more experienced students, as well as people from different river backgrounds, just so that students have the opportunity to work together and benefit from the diversity of backgrounds and approaches. If nothing else, you will learn what is difficult and does not work.

Acknowledgement of Risk in Swiftwater Rescue Training

Because of the risk inherent in any whitewater or river activity, we want to make sure you are aware of these risks and acknowledge them prior to the class. Simply put, we cannot guarantee your safety. If a river rescue or safety class is to be effective and give students whitewater experience and hands-on training, it is not going to be safe. In order for our instructors to provide realistic training with challenges that simulate actual rescue conditions, we recognize there is always the chance that someone is going to get injured. We may be walking along slippery rocky shorelines, swimming in cold whitewater, and working with ropes and rescue equipment in very realistic scenarios. All of this involves risk, and we will try our best to manage risk in a way that creates a balance between the risk students are exposed to and the levels of challenge presented during the training.

To receive a WRI certification from this class you will be expected to demonstrate the ability to perform some specific skills we cover in the course, such as defensive and aggressive swimming,

throwbagging, live bait, z-drags, etc. You may be asked to perform these skills in test stations or drills, or you may be asked to perform them in scenarios. If there is anything you would like us to spend additional time on or something you do not see in the curriculum, let the instructor know. We're flexible and want this to be the best possible training for you.

NFPA 1670

The National Fire Protection Agency established standard 1670 to assist the authority having jurisdiction (AHJ) in assessing the hazards related to technical search and rescue within the response area. The stated scope of code 1670 is to set minimum requirements, and not to limit training or use of equivalent systems or methods.

NFPA 1670 establishes minimum standards for a variety of technical search and rescue operations. These operations are:

- Rope
- Structural Collapse
- Confined Space
- Vehicle
- Water
- Wilderness
- Trench and Excavation
- Machinery
- Cave
- Mine and Tunnel
- Heliocopter

NFPA 1670 requires the AHJ to determine the level of technical operations which may be utilized in response area. It establishes three levels of training:

- Awareness Level. This level represents the minimum capability of organizations that provide response to technical search and rescue incidents
- Operations Level. This level represents the capability of organizations to respond to technical search and rescue incidents and to identify hazards, use equipment, and apply limited techniques specified in standard 1670 to support and participate in technical search and rescue incidents.
- Technician Level. This level represents the capability of organizations to respond to technical search and rescue incidents and to identify hazards, use equipment, and apply advanced techniques specified in standard 1670 necessary to coordinate, perform, and supervise technical search and rescue incidents.

NFPA 1670 has many requirements for the AHJ to maintain compliancy. For example, the AHJ must maintain documentation of all training done by individuals, create Standard Operating Procedures for incidents in the response area, and provide continuing education to maintain the level of training necessary.

To view the standard in its entirety, contact the National Fire Protection Agency or visit them online at www.nfpa.org.

The Whitewater Rescue Institute strives to provide you with the most useful and applicable techniques for water search and rescue. The Swiftwater Rescue Technician course is designed to provide you and your agency with the tools to safely effect a rescue in your jurisdiction. It should be noted that to reach NFPA 1670 technician-level certification in Swift Water Rescue, the individual must also reach technician level in Rope Rescue. This Swiftwater Rescue Technician course is the first step in reaching that requirement.

NFPA 1006

NFPA 1006 was established to assist agencies in specifying the minimum job performance requirements. It creates standard expectations for training levels established in standard 1670. It requires an evaluation of AHJs and individuals seeking compliancy. In order to help agencies with their training, the Whitewater Rescue Agency offers this evaluation to the AHJ.

Section 1
Hydrology

The most important skill anyone can bring to the river is the ability to read water. It is easy to look at a flooding river and see the power. But when a person looks at a river at normal flows, the perception is quite different. More often than not, the river is underestimated. Reading water is a difficult skill to develop. It takes a lot of time on various rivers to reach a point where we understand what to expect.

Moving water, either at flood stage or low flows, is **powerful** and **relentless**. However, it is also **predictable**. And it is within this predictability that we function.

Reading water enables us to recognize and avoid potential hazards. We can decide the safest, most efficient way to access and stabilize a victim. We can determine safe eddies and our own ability to self-rescue.

The three basics to Hydrology:

1. **Flow**
2. **Gradient**
3. **Features**

Flow: Cubic Feet per Second (CFS)

One cubic foot is about the size of a basketball. If you were to stand on shore and draw a line across a river, a river flowing at 10,000 cfs would have 10,000 basketball sized containers of water pass by that line every second. The flow of a river varies from day to day. A calm river at low flows may be very violent at high flows. Or an obstruction at high flows may be buried, but at low flows be exposed and dangerous.

It is extremely important to know the flow of the river you are working on and to know how an increase or a decrease in flow will change the character of the river. You can find flow

information online at www.americanwhitewater.org or http://waterdata.usgs.gov/nwis/rt.

Gradient: Feet per Mile

The gradient of a river has a significant effect on the character of a river. To give you a reference point, the Grand Canyon of the Colorado has an average gradient of 9 ft/mile. The Middle Fork of the Salmon has an average gradient of 28 ft/mile. The Little White Salmon has an average gradient of 217 ft/mile.

Taken alone, gradient or flow do not give us enough information. We must look at how these two ingredients combine to make whitewater.

The size of the whitewater corresponds directly to the increase in gradient and flow. A river may have a very steep gradient (>100 ft/mile) but only be navigable with a low flow (<1000cfs). Or vice versa: a river may have a high flow (>40,000 cfs) but only be navigable with a minimal gradient (<50 ft/mile).

Terminology

river right: Facing downstream, the right hand shore is River Right. Facing upstream the left hand shore is River Right.

river left: Facing downstream, the left hand shore is River Left. Facing upstream the right hand shore is River Left.

current: The direction of river flow. It is important to note that this may differ from the direction of the shoreline. In a straight channel, the fastest current is in the middle of the river, just below the surface. On a corner, the fastest current is along the outside edge of the bend.

eddies: A current flowing in the opposite direction of the river, eddies are formed on the downstream side of an obstruction. Water passes the obstruction and fills the space behind.

eddy line: The line where the eddy current (flowing upstream) and the river current (flowing downstream) meet. For a swimmer or a boater, the eddy line must be crossed as efficiently as possible, this generally means at the top of the eddy where the eddy line is the narrowest.

pillow: The building up of water on the upstream side of a rock or obstruction. Often a pillow will form a V shape with the center of the V being the most upstream point.

undercut: A rock or obstruction that water is pushed underneath. This can be spotted by the absence of a Pillow.

wave train: A series of waves. Often a wave train will form a V shape, with the center of the V being the most downstream point. It is usually created by the combination of gradient and constriction of the river channel.

tongue or V: A formation created by a series of waves. The center of the V is the fastest moving water. A boater or swimmer,

in general, should aim for the center of the "V".

breaking wave: A large wave that has a foam pile on top. A breaking wave is similar to a hydraulic in that it can stop and flip a boat, but generally it will not hold a boat or swimmer.

hydraulic or hole: As water passes over a shallow rock it is forced down and then up. The water then folds back on itself. There are two distinct shapes holes can form—a smiling shape or a frowning shape. It is important to recognize these, for a frowning hole can be significantly more dangerous than a smiling hole.

low head dam: A man-made hydraulic that has a unique shape that can trap a swimmer or boat indefinitely.

strainer: A tree or any obstruction that water passes through and objects (including people) do not.

sieve: A formation of rocks that allows water to pass through but not objects.

Whitewater Classification Scale

Class I- Moving water without waves or holes that has an obvious route.

Class II- Faster water with small waves, hydraulics, and obstacles

Class III- Distinct formation of rapids. Waves may be up to 3 or 4 feet in height and usually a maneuver involved in order to navigate the rapid.

Class IV- Waves and hydraulics increase in size, and two or three maneuvers are necessary. Advanced.

Class V- The upper limits of navigable water. Multiple moves, obstacles, and hazards. A swim would be life threatening. Experts only.

Class VI- Traditionally unrunnable. However, in recent years, kayakers have been running what could be called Class VI.

It is important to know that this scale is extremely vague and subjective. A class III rapid to one person may seem class IV or even V to another. Be aware and do not rely on one person's opinion.

Section 2
Preparation

Preplanning and Training

Preplanning and training are essential for any safe and successful rescue. It is important to assess the river and the hazards that exist on your selected river trip or response area. Once hazards have been identified, a hazard management plan should be created.

When developing this plan, it is important to take into account your group or organizational strengths and weaknesses.

Equipment

The minimum equipment for a rescuer entering the water:

- Helmet
- Personal Flotation Device
- Knife
- Whistle
- Wetsuit/Drysuit
- Appropriate footwear
- Gloves

The minimum equipment for a shore based rescuer:

- Helmet
- PFD
- Knife
- Whistle

Once a plan has been developed, it is equally important to practice this plan. The more realistic the training operation can be, the more prepared you and your team will be for a real event.

Scene Assessment

- **Hello-** Communicate with the victim to help themselves
- **Reach-** Reach for the victim
- **Throw-** Throw a rope to the victim
- **Row-** Row or paddle a boat to the victim
- **Go-** Go into the water after the victim
- **Helo-** Call in a helicopter.

When assessing a river rescue scene, safety is paramount. A good rescuer has a healthy respect for the river and knows how easy it is for things to get out of control. An accident is rarely caused by one big mistake. It is usually a series of choices made that lead to an unfortunate outcome. The rescuer's first priority is herself. She cannot begin to help another until her own safety is guaranteed. Her second priority is the safety of her rescue team members. The safety of the victim is last. It is understood that this hierarchy may change depending upon the rescuer's relationship to the victim. If the victim is a family member or close friend, more risks will likely be taken to save that person than a Search and Rescue team might take responding to an unknown person.

Despite this, keep in mind that a *good rescue is a rescue in which no additional people get hurt*. Use **Hello, Reach, Throw, Row, Go, Helo** to help guide your decisions on how to access a victim. Always attempt river rescues in this order.

River Rescue Guidelines

1. **Always wear proper equipment**
2. **Contain the rescue**
3. **Always have a back-up plan**

Proper Equipment

For a rescuer who will enter the water, the minimum equipment this is a helmet, a personal floatation device (PFD) with knife and whistle, a wet or dry suit, proper footwear, gloves, and a throwbag. For any shore-based rescuer who is within 20 feet of the shoreline, the minimum equipment is a helmet and PFD.

Contain the Rescue

1. Downstream Safety

It is important to contain the rescue scene and protect the rescuers and/or victim from being lost downstream. A self-rescue plan should be established

2. Upstream Spotter

A person must be designated as the upstream spotter. This person has the job of alerting the rescue team of any debris or hazards that are entering the rescue scene. This person must also be ready to stop any other river users from floating into the scene.

Back-up Plan

Rarely do things go as expected on the river. It is important to see all possible outcomes of a rescue and plan accordingly. The best river rescuers are those who see the problems before they happen and avoid them.

Search Criteria

The majority of topics in this manual and this course focus on getting the victim out of the river and onto shore. However, sometimes just finding the victim is a big part of the job. Whether it is a rescue or a recovery, there are four phases.

Phases of Rescue
L – locate
A – access
S – stabilize
T – transport

In order to locate a person on the river, a two crucial pieces of information must be obtained.

1. Time last seen
2. Point last seen

With this minimal information, we can set up the parameters of a Hasty Search.

- If possible, spotters should be sent to the furthest distance downstream the victim could float.
- Then, two water-based crews should search each shoreline for any *obvious* evidence of the lost person. This is a fast paced search, and searchers should not spend too much time looking in all nooks and crannies.
- Two land-based crews should search each shoreline for *obvious* evidence, again, not wasting too much time on the minute details (which will come with the second phase of the search).

If the person is not found during the Hasty Search, then it is time to move into phase two—the Detailed Search. This is where every possible location of the victim is searched.

Rescue Organization

A rescue scene can be chaotic. Adrenalin increases with each passing moment and each person will respond differently to the accident—some may be panicked, others calm. Many times there may be multiple agencies responding to one incident. It is, therefore, important to organize the rescue effort in the most efficient way possible.

Incident Command System

Incident Commander-

Generally the IC is the person with the most experience. The ability to delegate responsibilities is a necessity. S he should have a bird's eye view of the scene and be watching for all possible outcomes and hazards. S he will interface with other agencies and potentially hand over command to more experience personal.

Safety Officer-

The Safety Officer monitors all aspects of the rescue operation and maintains safety protocols. S he reports directly to the IC and has the authority to "call stop" on any unsafe activity.

Logistics Officer-

The job of the Logistics Officer is to disperse gear as needed to the rescue team. Further responsibilities include communications within the team and with other agencies, maintaining written record of the incident and response, and monitoring bystanders.

Incident Command System
Incident Commander
Safety Officer
Logistics Officer
Rescue Technicians
Rescue Team #1
Rescue Team #2
Upstream Spotter
Down Stream Safety
Throwbag Team
Live Bait Team
Chase Boat

Downstream Safety-

This team of individuals must use their ability to read the water and set up safety in the appropriate place to guarantee that no rescuer or victim will be lost downstream.

Upstream Spotter-

Hazards and other river users often float into rescue scenes. The upstream spotter must be located in a spot where s/he can see upriver yet communicate with the team.

Rescue Team-

These individuals are given the job of rescuing the victim. Strong swimming capabilities and first-aid training are a must. As any person who has tried to talk to a friend or coworker on the river knows, communication can be difficult. Communication, however, is essential for avoiding hazards and for efficient rescues. There are many high-tech radios that alleviate this problem. However, there is no guarantee that they will work. The best possible solution is the easiest—whistle and hand signals.

Communication

Hand Signals

Hand signals are often the most effective way to communicate on the river. There are numerous internationally recognized signals, but it is important that you discuss what signals you will be using with your team members.

Whistles

Every rescuer should have on his PFD a whistle and know the internationally recognized signals.

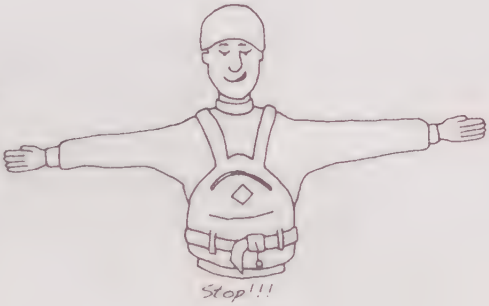
One Blast- "Stop! Look Here"
Two Blasts- "Upstream"
Three Blasts- "Downstream"
Three Blasts (Repeated)- "Help!"

Help!!!
(one or two arms waving)

"I'm Okay" or
"Are you Okay?"

First Aid

Point Positive


Stop!!!

"Eddy Out" or
"Tension"

Go!!

"Slack"

Section 3
Medical Considerations

Medical Considerations

It is recommended that any person spending time outdoors have some level of first aid training. This is a brief synopsis of medical conditions and should not serve as a replacement for proper training.

Swiftwater is a unique rescue environment in that injuries occur often and very easily. It is important to maintain a high level of suspicion for any person taken out of the water. Remember to always check your **ABCs** (Airway, Breathing, Circulation).

Trauma-
From sprained joints to fractured bones, any number of traumatic injuries can occur in the river. cervical spine precautions should always be taken on a victim with an unwitnessed swim. Furthermore, be on the look out for major bleeding and shock.

Signs/Symptoms (S/S) of Shock
Diminished Level of Responsiveness (LOR)
Pale, cool, clammy skin
Nausea/vomiting (N/V)
Lethargy
Increased, thready Heart Rate (HR)
Thirst

Treatment (Tx) for Shock-
Stop the bleeding (if possible)
Removing wet clothes
Keep warm
Elevate feet
Evacuate

Hypothermia-

Humans lose their body heat 25 times faster in water than in air. Hypothermia can occur on very hot days if the person spends too much time in the water.

S/S for Mild Hypothermia	Tx for Mild Hypothermia
Shivering	Get out of wet clothes
Diminished LOR	Simple sugars
The "umbles"	Get the patient moving
Increased HR	
S/S of Severe Hypothermia	**Tx for Severe Hypothermia**
No shivering	Treat like glass
Deminshed LOR	Prevent further heat loss
Unresponsive	Consider heat to hands and feet
More "umbling"	
Decreased HR	

Hyperthermia-

Heat exhaustion is common in outdoor activities and can lead to Heat Stroke, a serious life threat.

S/S of Heat Exhaustion-	Tx of Heat Exhaustion-
Headache	Remove from heat
Cramping	Cool by sponging cool water and fanning
Pale, warm, sweaty skin	Refuel and rehydrate slowly
Increased HR	Rest for 12-24 hours
Diminished LOR	
S/S of Heat Stroke	**Tx of Heat Stroke**
Diminished LOR	Remove from Heat
Unresponsive	Cool patient rapidly
Seizures	Evacuate
Coma	
Hot, Dry, Red Skin	
Rapid HR	

Heart Attacks-

It is important to know the medical history of the people you are working or floating with. However, it is possible for a person to have a heart attack from merely falling into the cold water.

S/S of Heart Attack-	Tx for Heart Attack-
Sweaty	Position of comfort
Crushing pain in chest	CPR if necessary
Radiating pain	Evacuate
Increased HR	

Allergic Reactions-

Severe allergic reactions are serious life threats. A lack of previous history is not a guarantee of immunity. A quick response and evacuation is necessary to save a person's life.

S/S of Severe Allergic Reaction-	Tx for Severe Allergic Reaction-
Hives (itchy and red skin)	Position of comfort
N/V	50 mg of Benedryll (self-administered)
Airway swelling (respiratory distress)	Epinephrine (Epi Pen self-administered)
Increased HR	Evac
Chest pain	

Drowning-

Any person submerged in water for any length of time should be closely monitored for developing respiratory distress. Aspiration of water can cause significant damage to lung function and cause a person to die from a condition known as secondary drowning.

Survival of submersion is affected by three conditions:

1. Duration of submersion (shorter period the better)
2. Temperature of water (colder the better)
3. Age of victim (younger the better)

It should be noted that in cold-water submersion (<78 degrees Fahrenheit), the longest known period of complete submersion and total recovery is 66 minutes.

Tx for Submersion-
ABCs
C-spine precautions
Monitor for developing respiratory distress (24 hours)

Drowning was the third largest cause of accidental death in 2007. The majority of victims were male, were under the influence of alcohol, and were not prepared to enter the water. It is necessary as a Swiftwater Rescue Technician that you always wear the proper equipment.

Section 4
Self-rescue

Before you can rescue another, you must first be able to self rescue. In most cases, self-rescue will involve the defensive swim technique and the aggressive swim technique. Knowing when to rest by defensively swimming and when to start moving to shore aggressively comes from practice and your ability to read water. As a rescuer, you should be comfortable swimming in class III whitewater.

Defensive Swim Technique

The defensive swim technique allows the swimmer to:

1. See upcoming obstacles
2. Avoid foot entrapment
3. Save energy

The technique is simple. Let your PFD float you with your feet downstream and up on the surface of the water. Be aware that as you lift your head to see downstream, your tailbone sinks lower into the water and can be vulnerable to rocks. One sharp rock can cause serious injury.

The defensive swim technique should be used when you are in whitewater of any size. As you float, look downstream for obstacles. If your feet are in the proper position, you will be able

to push off of rocks and avoid collision. **Do not attempt to stand-up in the current.** If your foot or leg gets stuck, you will instantly have the full force of the current upon you. People have died in less than two feet of water!

Goals of defensive swim technique:

1. Avoid injury
2. Save energy

Use a ferry angle to maneuver. To do this, point your feet at the obstacle you wish to avoid, and pull your body away using back strokes. Do not allow your torso to get swept downstream of your feet. A 45-degree angle to the current is sufficient.

This will allow you to conserve energy until you are through the difficult section of water.

Aggressive Swim Technique

Goal of Aggressive Swim:
To self-rescue
"The best rescue is the one that never happens!"

Once you have floated through the rapid, it is now time to move towards shore.

To do this, roll onto your stomach without letting your feet drop below the surface. You can avoid foot entrapment by keeping your feet on the surface.

Depending on the situation, you may need to use a ferry angle to avoid obstacles and make it to shore. Swim using an aggressive crawl stroke. Remember that you should enter and exit eddies as close to the top as possible. It is sometime helpful to roll as you enter the eddy.

Strainers: Self Rescue

- **Aggressively avoid strainers**
- **Do not get swept underneath**

One obstacle to be on the lookout for, especially during spring runoff, is a strainer. Strainers are any object that allows water to pass through, but not objects (i.e. logs, fences, automobiles). The danger is in hitting it hard, getting caught on broken branches, or being flagged around the object by the powerful current.

Strainers are the number one hazard on western rivers and can be appear overnight. Strainers will often form on the outside bank at a bend in the river. However, strainers can form anywhere.

Be ready to aggressively avoid strainers. This may mean paddling or swimming to the opposite shore, or even portaging.

If you are swimming and it is clear that you are not going to avoid the strainer, then you should turn onto your stomach and swim aggressively towards the strainer. As you approach, stay flat on the surface with your arms in front of you. Try to launch yourself up and over the strainer. The worst possible place to be is underneath the strainer.

Hydraulics

Many hydraulics, or holes, can hold a swimmer indefinitely. When evaluating a hole, first take note of its shape. Is it smiling or frowning? Next, look at the distance from the face of the hole to the boil line. Is this a long or short distance? Finally, look at the height from the top of the hole to the bottom. Again, is this long or short? As these two distances increase, so, too, does the power and danger of the hydraulic.

If you happen to swim through a hole, bring your knees to your chest and tuck up into a ball. This serves two purposes: (1) protects you from foot entrapment, and (2) it pushes you deep into the green water to get past the boil line.

If you do not get past the boil line, you will be recirculated into the hole. There are two exits from the hole: (1) the edges and (2) the green water outflow, along the bottom of the river. If the hole is frowning (edges upstream of the center) or large, the edges might not be an option. The only option then is to find the outflow. To do this, tuck up into a ball as the water pushes you down. Once underwater, open up like a starfish to increase surface area exposed to green water. It may take several attempts if the hole is powerful.

Entrapments

Entrapments are one of the most serious accidents that can occur on the river. The force of water increases exponentially with the speed of water. As a rescuer, it is of the utmost importance that you assess the accident scene for possible entrapment hazards, and avoid becoming entrapped yourself.

Current Speed	Force on Legs	Force on Body	Force on Swamped Boat
3	20	30	170
6	70	130	670
9	150	300	1500
12	270	540	2700

Force is pound per square inch.

To avoid entrapments, keep your feet on the surface of the water, avoid rocks (in particular, undercut rocks), rope, and strainers. If you happen to become entrapped, remain calm to conserve energy, try to free yourself, and reach for the surface with your palm facing upstream. We will discuss techniques for extrication from entrapments in Section 5.

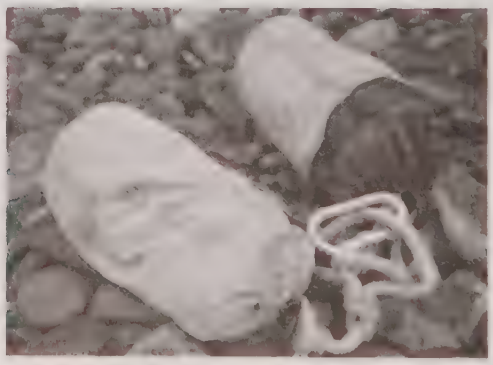
Section 5
Simple Rope Rescue

Throw bags are an essential tool in swiftwater rescue, and are essential equipment for any river runner. Many boaters have died because of the lack of rope, and we, as swiftwater technicians, should never be on the river without one.

Rope, however, is also a hazard if improperly used. Any time you throw a rope into the river, you must be certain that you will not lose the rope downstream. Rope can easily wrap around or entangle a swimmer in the water, thus causing an entrapment hazard. *It is better not to throw, than to throw and let go!*

Before enacting a throw rescue, consider helping the victim self-rescue or reaching for the victim. This can include reaching a hand or even a stick out to the swimmer. The best rescue is the simplest rescue!

Throw Bag Anatomy



Throw bags come in all different shapes and sizes. The vast majority have between 55 and 75 feet of rope in them.

Throw bags should be test-thrown before every river trip. If a rope has been stored too long, it may not deploy properly.

There are many different types of rope used in throw bags. The two most common are polypropylene and spectra/dyneema.

Types of Rope

1. **Polypropylene**-*Qualities:* dynamic, floating, 1000-2000 lb. breaking strength, exposed core is black, not adequate for tensioning!!
2. **Spectra/Dyneema**- *Qualities:* static, floating, 3000-4000 lb. breaking strength, exposed core is generally white, can be used as a tensioned line

Throw Bag Techniques

Throwing End

1. Communicate with swimmer- "Swim to shore!"
2. Size up shore line- Where will swimmer pendulum? Into hazard? Do you have proper footing? Do you have belayer? Is there a rock or tree for friction wrap? Can you do a dynamic belay?

3. When possible, try to have two people belaying on shore for every one in the river.

4. Open bag halfway.
5. Hold the end in one hand.
6. With other hand, grab material of the bag, not the handle on bottom.
7. Make eye contact with swimmer and yell "Rope," so the victim sees the rope coming.
8. Wait until the swimmer is directly in front of you, at the shortest possible distance.
9. Throw the bag directly over the swimmers head.

10. **Do not wrap the rope around your wrist or any appendage.**
11. **Do not stand downstream of the tensioned line.**
12. Brace for the tensioned line, use belayer, friction wrap, or dynamic belay.
13. If possible, vector the line.
14. Coil the rope in, preparing for additional throws.

Receiving End

1. Swim towards the throw bagger.
2. Be ready to swim for the rope.
3. Place rope over the shoulder opposite to the shore you will pendulum towards.
4. Stay as flat as possible to minimize surface area exposed to the current.
5. Do not wrap or get entangled with the rope.

It is important to be able to throw coils as well as a stuffed bag. To throw a coil, coil the rope into one hand (butterfly or mountaineer's coil). Coils should be equal length. The end of the rope should be in the coils. Grab the middle of the rope with non-throwing hand. Toss the coils, always tossing the end of the rope, not the middle. You should be able to make two throws in rapid succession (<20secs).

You cannot trust a swimmer to hold onto the rope. Therefore it is important to minimize the time they spend in the water. Whenever possible, vector the line in. Once the swimmer has grabbed the rope, and the thrower is anchored, have one person move down the shoreline holding onto the rope by hand or with carabiner and webbing. This will shorten the distance the swimmer must pendulum.

When restuffing a throw bag, open the bag up completely. Hold the bag in your hands with the rope coming over your shoulder. Stuff the rope into the bag inch by inch. Do not stuff clumps of rope into the bag. It may not deploy properly.

Section 6
Contact Rescue

Keeping in mind the hierarchy of safety (Reach, Throw, Row, Go), at some point the decision may be made to perform a "Go," or contact rescue. This is, of course, the highest risk option and should only be chosen when all other possibilities have been ruled out.

The use of canoes, kayaks, and rafts should be considered in the scene assessment. If you cannot reach the victim, and throwing is not an option, then a watercraft or "Row" rescue should be considered before a "Go" rescue is attempted. As the rescuer becomes more comfortable with the use of these crafts, s/he may consider using it before attempting a throw rescue.

Below the strengths and weaknesses of each craft are outlined.

	Agility	Speed	Access
Kayak	Very	Fast	Class I-VI
Canoe	Somewhat	Medium	Class I-VI
Raft	Not Very	Slower	Class I-VI

	Operation	# of Victims	Unresponsive Victims?
Kayak	Difficult	1	Very Difficult
Canoe	Very Difficult	1-2	Difficult
Raft	Challenging	>10	Challenging

Once a "Row" rescue has been attempted or ruled out, then the decision to attempt a "Go" rescue may be made. There are many different techniques to perform a contact rescue; below are a few options.

Scene Size-Up

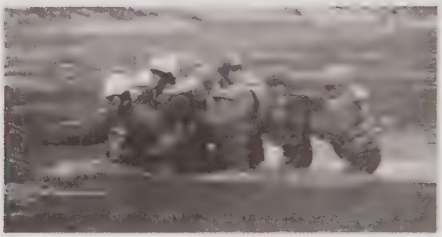
Scene size-up is the most crucial aspect of the contact rescue. The rescuer must be certain that self-rescue is an option. The choice to enter the water can only be made if the rescuer is 100 percent certain that s/he is able to swim to shore. Keep in mind that about one third of drowning victims are rescuers.

Furthermore, the rescuer must quickly assess the victim. Victims may have different responses to immersion. Among possible responses is panic. A panicked victim can easily overwhelm a rescuer. It is therefore necessary to take precautions such as approaching from upstream, talking to victim, or preventing victim from rolling over on top of you.

The in-water rescuer must always have a back-up plan of self-rescue. A safe eddy should be chosen before attempting a rescue swim.

In addition, the on-shore team must be watching for hazards, and in the case of uncertainty, must pull the in-water rescuer back in. The on-shore team's responsibility is to maintain a heightened level of awareness and prevent any accident from occuring. Because of their position, they should be able to maintain a broad view of the scene, while, the in-water rescuer is focused on the victim.

Shallow Water Crossings



Shallow Water Crossings are a simple, yet effective way to maneuver in swift current. By working as a team of two or more, rescuers can link together to help stabilize one another. There are many different techniques and formations to create.

Guidelines for effective crossings

1. **Create an eddy**
2. **Keep the group close**

Riverboards

Riverboards can be a versatile and effective rescue tool for a variety of rescue situations. While the additional power of fins makes a rescue swimmer faster and more mobile, the additional floatation of the board makes the rescuer safer and more versatile in virtually every river rescue situation. Riverboards can be utilized as a way to access someone in trouble on the river, help swimmers get to safety, and can be a chase or downstream safety option. They can be used for hasty searches, as improvised litters for patient evacuations, and much more. Riverboards are also a

great way for people to get comfortable swimming in whitewater and to learn how to read moving water, how to recognize and avoid hazards, and how to maneuver in current and whitewater. More firefighters and search and rescue teams are recognizing the value of incorporating riverboards in their swiftwater team training because of their flexibility and convenience. In our swiftwater rescue technician classes, we encourage students to try the riverboards and incorporate them in scenarios for additional practice. We tend to emphasize riverboards in classes where we have students who might actually use them as a rescue tool (i.e. search and rescue personnel). We also offer specialized riverboard and rescue swimmer intensive training in which students use the boards for a variety of contact rescues and scenarios.

Rescue Swim

The simplest option is for the rescuer to swim the victim to shore. Depending on river conditions, this option can also be the highest risk. It is extremely difficult in moving water. Timing is very important in this operation. The rescuer must enter the water at the proper time so that s/he can approach the victim from upstream. Entering the water too early will mean that the rescuer will have to fight the current to catch the swimmer.

Once the swimmer is contacted, the rescuer should grab the swimmer by the shoulder opposite to the shore they are going toward and swim. At this point, the on-shore team may choose to throw a rope to the rescuer. This may be difficult for the rescuer to hold and could cause injury. However, this method has worked in the past and has saved lives.

Live Bait

The next option is for the rescuer to hold on to the end of a rope with one hand and have a belay team hold the remainder on shore. Timing is important in this option as well. The rescuer should approach the victim from upstream. Once the victim has been contacted, the rescuer will have to hold the victim with one hand and the rope with other. Again, this can cause injury to the rescuer in swift current.

Gear needed for Live Bait:
- Two throwbags
- Two carabiners
- Quick Release Harness

One of the best ways to perform Live Bait, or Tethered Rescuer Swim, is as follows:

Throw bags should be linked together (bag to end of rope). The end of the rope should be clipped into the Quick Release Harness with a locking carabiner (NFPA states that this carabiner must be steel). The rescue swimmer should again focus on timing his approach to the victim so that s/he approaches from upstream. Once contact is made, the rescuer must signal (head tap) to the belay team that s/he his ready. The belay team will then lock down on the rope and pendulum rescuer and victim to shore.

The Details of Live Bait

1. Rescuer should be prepared to self-rescue
2. Rescuer should be trained and practiced with Quick Release Harness
3. Harness should be laced properly
    a. Up through the metal plate
    b. Down through the metal plate
    c. Through the plastic buckle
4. Rope drag should be minimized
5. Rescuer should start upstream of belay team
6. Rope should be held out of water
7. Rope should be belayed as needed—too much rope will result in drag, and too little will result in swimmer fighting belay team.
8. Belay team should maintain 2:1 ratio of persons on shore:in water
9. Whenever possible, a vector should be used to help get rescuer and victim to shore quickly
10. Downstream Safety must be set
11. Always have a back-up plan

Section 7
Entrapment

Entrapments are quite possibly the scariest events on rivers. We must always act quickly in entrapment situations. A person who is entrapped is not in a static position and can easily go from a heads-up to a heads-down situation. The first goal with entrapments is to stabilize the victim and to remember basic guidelines.

Strainers

Priorities:
1. Avoid at all cost!!
2. Do not get swept under

Strainers are the number one hazard of which to be aware. A strainer is usually a tree that has become lodged in the current on shore or between rocks. However, it can be anything (a fence, a rope) that allows water to pass through but not objects. Strainers can pop up anywhere on the river, and can often be hidden underwater. **The main priority is to avoid these entrapment hazards.** Perhaps you can paddle or float down the opposite side of the river, or if necessary walk around; regardless, under no circumstances should you ever put a rescuer in a position where they may become entrapped.

If, however, you are caught off guard by a strainer when swimming, aggressively swim towards the hazard so that you can climb up on top of it and avoid being swept underneath.

Foot Entrapments

Priorities:
Never stand up in moving water!!

Foot entrapments can occur anywhere on the river and can be impossible to remedy. A foot entrapment occurs when a

swimmer's foot becomes stuck on an obstacle and the current of the river carries the person downstream. If the river is deeper than the victim's arms are long, the victim will not be able to maintain an airway. Foot entrapments, although scary, are easily avoided. When swimming in the water, it is crucial that you keep your feet on the surface (in both the aggressive swimming position and the defensive swimming position).

Entrapment Remedies

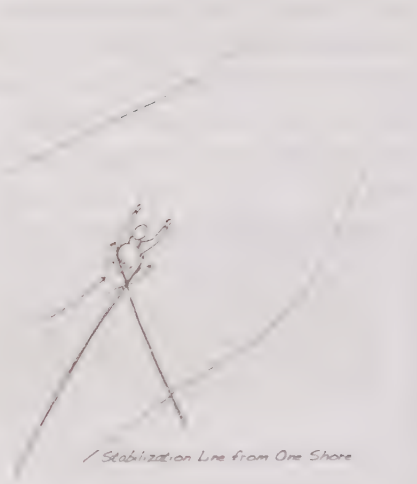
The number-one priority is to stabilize the entrapment victim as quickly as possible. You must always consider an entrapment as a dynamic emergency. If the patient has an airway, you want to keep it that way. If they do not, then you need to get them one quickly. Keep in mind, though, that despite the necessity for speed, you must follow the basic guidelines for a safe rescue.

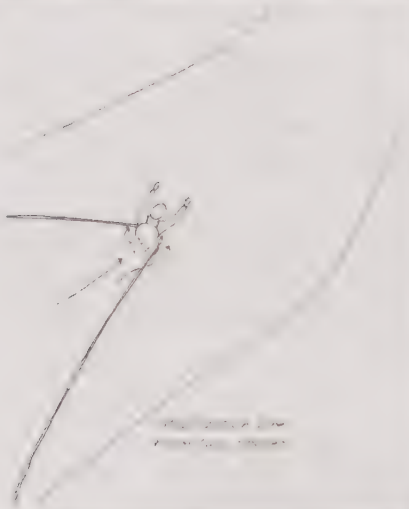
In extracting an entrapped victim, it is important to note that most people come out of entrapments the way they went into them. When dealing with strainers, pull the victim up and away from the strainer before pulling them to shore.

Step 1: Can you throw them a rope?
Step 2: Can you access from downstream and get hands-on stabilization?
Step 3: Can you get them a stabilization line?

Stabilization Line from One Shore:

1. Toss the rope upstream of the victim.
2. Allow rope to pass by victim and tail off in the current.
3. Retrieve rope end.
4. Move upstream with retrieved end.
5. Minimize space between two ropes.





Stabilization Line from Two Shores:

1. Toss the rope downstream of the victim.
2. Snag the victim under the arms.
3. Walk upstream on both shores until the angle of the rope at the victim is less than 90 degrees.

Simple Cinch:

1. Clip a carabineer on one side of the stabilization line.
2. Throw rope across the river.
3. Minimize space between stabilization line and cinch.

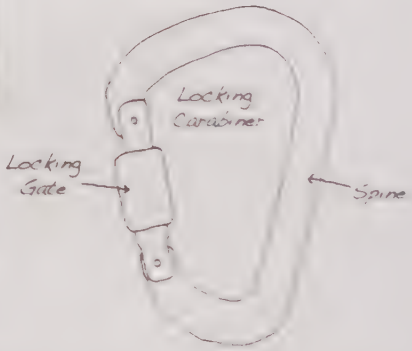
Section 8
Technical Rescue

Technical rescues are often an exercise in communication. And communication on the river is extremely difficult—even with radios. That is why it is of the utmost importance that you and your team practice these skills in a realistic setting before they are ever applied.

Technical Rescue

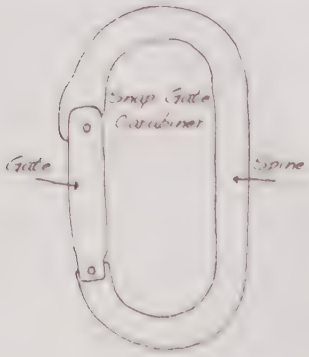
Technical Gear

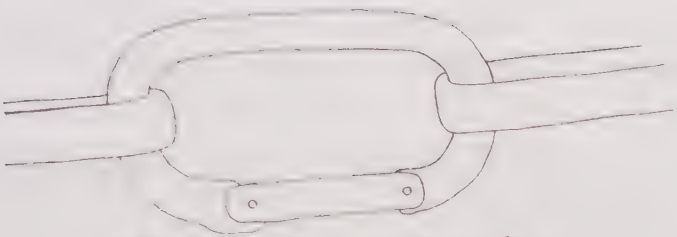
- Carabiners
- Low stretch ("static") rescue line
- Pulleys
- Prussik loops
- Webbing



Carabiners-

Carabiners come in different shapes and different sizes. It is important to have the proper type for your agency or team. They can be either locking or non-locking. Each type of carabiner has a different breaking strength and are labeled accordingly. Strength is measured in kilonewtons (1 KN = 220 lbsf.). An Omega aluminum locking carabiner has a breaking strength of 24 KN along the spine, but a 8 KN cross-loaded. (1 KN = 220lbsf). Much of the strength of carbiners comes from the gate. It is therefore important that a carabiner never be opened when it is under tension.





Properly Loaded Carabiner

Never Cross Load!!

Low-Stretch ("Static") Rescue Line-

A low-stretch rescue line should be considered part of your essential equipment. These lines generally have a high breaking strength and can be used to dislodge a pinned boat, create a tensioned diagonal, or for many other uses. There are many different types of rope on the market, each with its own set of positive and negative attributes. You or your agency should first determine what you intend to use the rope for, and then find a rope that best fits your needs. The current standard is a low-stretch nylon kernmantle rope. The core (or kern) has nylon strands laid parallel, without any splices, and protected by a braided sheath. This type of rope provides minimal stretch. Breaking strengths are dependent upon the diameter of the rope.

In evaluating the needs of your group or agency, a safe working load is 1:10. The NFPA requires a 1:15 working load. What this means is that if the rope is used as a life line for a total of 2 people (1 rescuer and 1 victim), then 2 kN (440 lbsf) of force will be applied to the rope. Using the 15 to 1 formula, the rope then needs at least a 30 KN (6,600 lbs.) breaking strength.

Rope Size	Typical Breaking Strength
5/16" or 8mm	15kN or 3500lbsf
3/8" or 9.0mm	20kN or 4500lbsf
7/16" or 11.1mm	30kN or 7000lbsf
1/2" or 12.7mm	40kN or 9000lbsf

Pulleys-
Pulleys are essential and have many applications in river rescue. Used properly, pulleys can reduce friction, add mechanical advantage, and change the direction of pull. There are many different sizes, shapes, and constructions of pulleys on the market.

The rope runs over the sheave of the pulley, which has either a bushing or a bearing, and is connected by an axle to the two side plates.

There are a few things to keep in mind when selecting a type of pulley to use. First, when using pulleys in systems, they feel twice the force of other devices; therefore, it is best to buy a pulley designed for rescue use, with work duty side plates and a metal sheave (avoid cheap, plastic sheaves).

Second, pulleys need to be sized to the rope you are using. A general rule to avoid weakening the rope is to have a pulley with 4 times the diameter of the rope. A 1/2" rope requires a 2" pulley.

Finally, pulley construction varies from bearings and bushings and Prusik minding pulleys (PMP) to traditional pulleys. For river use, a seal bearing construction is recommended to keep sand and grit from damaging the bushing. PMPs are not only convenient,

but decrease a team's exposure to risk by eliminating the need for a person to mind the prusik.

Prusik Loops-

Prusik loops have many uses on the river. A minimum of two should be carried by each person. A prusik loop is a two to three foot length of rope tied into a loop. The preferred knot is the double fisherman's; however, other knots can be applied. Stitched prusik loops can also be purchased. Stitching eliminates some uses of the prusik loop, but gives the prusik loop a higher breaking strengths. The prusik loop can then be used to tie a prusik hitch on the rescue rope. Prusik loops should be of low-stretch kernmantle construction and sized to the rescue line. A general rule is that the prusik loop should be 70% to 80% the diameter of the material it is being tied to.

Rope Size	Prusik Loop Size
3/8" or 9.5mm	1/4" or 6.4mm
7/16" or 11.1mm	5/16" or 8.0mm
1/2" or 12.7mm	3/8" or 9.5mm
5/8" or 16.0mm	7/16" or 11.1mm

Webbing-

Webbing slings can be very handy on the river. They can be used as a gear sling, anchor material, or flip line. Webbing comes in different sizes and construction. The most common type used on the river is 1" tubular. This has a breaking strength of 4,300 lbs or 25 kN. The webbing should be of spiral weave construction, as opposed to chain construction.

Simple Knots and Hitches

The goal here is to provide you with a few simple knots and hitches that can be used in many different applications. Keep in

mind that any knot or hitch will reduce the breaking strength of the rope in which it is tied.

Figure Eight Stopper

Figure Eight on a Bight

Prusik Hitch

Water Knot

Double Fisherman's

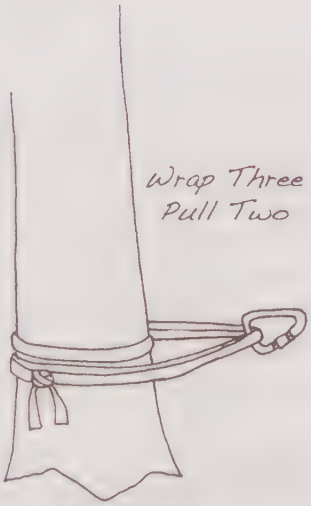
Simple Anchors

Anchors can be the most difficult aspect of setting up any system. For the purposes of this class and manual, we will not digress too far into anchors. It is recommended that you seek further education, training, and practice with anchor selection and set-up.

When selecting an anchor, choices can vary from rock to tree to car to bridge pylon. It is important that you take precautions against the failure of your anchor. Always back it up when possible. A general rule for selecting a tree as an anchor is "Five and Alive." This means that the tree should be at least five inches in diameter and alive.

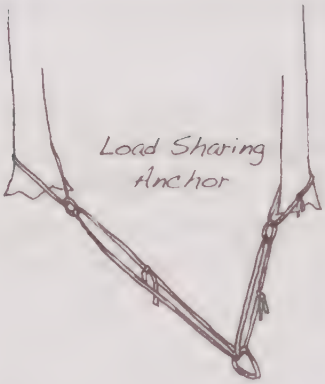
Webbing is a great tool for creating anchors. Low-stretch rope can also be used.

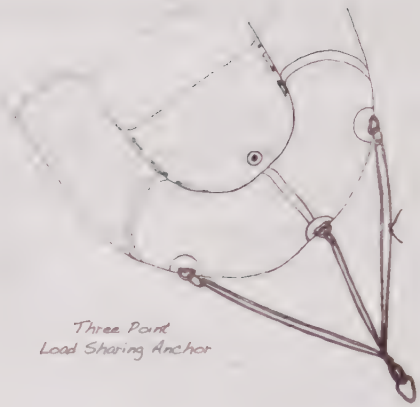
When setting up the anchor, there are a few things to keep in mind. First, the angle at the point of attachment should be less than 90 degrees. This will prevent vector forces multiplying the force onto the anchor. Second, the knot in the anchor material should not be at the point of attachment. The knot is the weakest point in the anchor material. Finally, get in the habit of attaching rope to metal—not rope to rope or metal to metal.



When anchoring to a boat there are many options, and each has its own set of risks and benefits.

Rafts-
D-rings are usually the most accessible points of attachment on a raft. However, D-rings are not a great point of attachment for a pinned boat—they tend to break. For a boat lower, a three-point load-sharing anchor off the bow is a great option. For a pinned boat a better option is to wrap around an entire tube or thwart.





Kayaks-

Most modern kayaks have metal grab loops. These can be great points of attachment. Beware: not all boats are created equal and some can break more easily than others. Keep in mind that it's best to attach rope to metal. When attaching to a metal grab loop, a sling between the carabiner and grab loop is advised. This will help eliminate the possibility of leverage forces pulling the grab loop from the boat. A great option, if possible, is to run a sling around the cockpit rim.

Canoes-

Canoes can be more challenging to attach a line to than rafts or kayaks. Grab loops are an option, but can certainly break. The thwarts or yoke are also an option, but easily break. Use your judgement, and use multiple points of attachment.

Mechanical Advantage

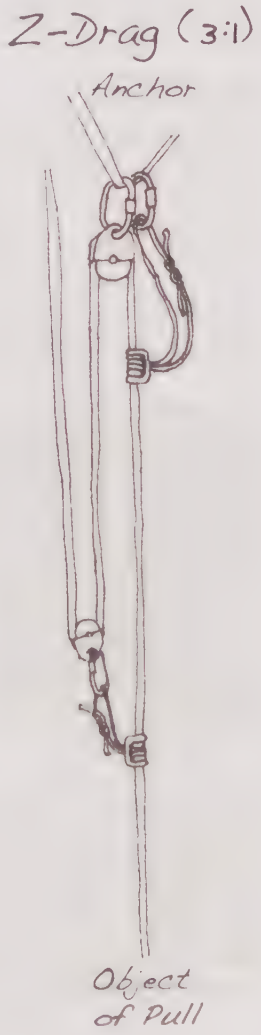
It should be noted that mechanical advantage (MA) is a basic tool that all swiftwater technicians should know how to utilize. However, MA is often relied on too heavily and used before other, simpler options are explored. Keep in mind that tremendous forces can be exerted on your technical gear, and failure can occur, causing serious injury to rescuers.

There are three different types of MA systems that technicians can create using technical gear—*simple, compound, and complex*. A simple system is one in which all the pulleys move toward the anchor at the same rate of speed. A compound system is any combination of two or more simple systems acting on each other. A complex system is one that does not follow the guidelines of simple or compound.

We will discuss two simple options for creating mechanical advantage—one simple and one compound.

Z-Drag (3:1)-

The Z-drag is not the easiest form of MA; however, it is the standard system used by swiftwater rescuers.



Gear needed for Z-Drag:

- Two pulleys
- Two carabiners
- Two Prusik loops
- Low-stretch kernmantle rope
- Anchor material

A Z-drag is a simple system that gives the technician a three-to-one mechanical advantage. What this means is that for every pound of force applied by the rescuer, three pounds of force act on the object (boat or anchor) of pull. Or, for every three feet of rope a rescuer pulls, the object of pull moves one foot.

The first step is to establish an anchor. Keep in mind the guidelines discussed

above for establishing an anchor. Next the object of pull must be anchored. The haul line (low stretch kernmantel rope) should be placed in a Z shape, with the first turn at the onshore anchor point and the second as far out towards the river as possible. Two Prusiks will be tied onto the line extending from the anchor to the object of pull. The first will be placed at the anchor the second directly below the second turn near the river. Pulleys are now placed in the corners of the Z. The pulley at the anchor point should be attached to the anchor material with a carabiner. The pulley at the second turn should be attached to the second prussik with a carabiner. The Prusik at the anchor point should be attached to the same carabiner as the first pulley.

Pig Rig (4:1)-

The pig rig is a compound system that gives the technician a four to one mechanical advantage. This system is useful for teams that have a limited supply of technical gear that may need to be used for more than just tensioning.

The first step is to establish anchors on shore and on the object of pull. A haul line (low stretch kernmantel rope) should be attached to both. A Prusik should be tied on the haul line and attached by carabiner to the on-shore anchor. The second haul line (low stretch kernmantel rope) is now used. Tie a figure eight on a bight (double figure eight) in the end of the rope. Extend this end as far out as the shore line will allow and place a small turn in it. A second anchor should be established. For the most efficient use of this system, the second anchor should be the same distance behind the first anchor as the first anchor is to the head of the system. This will allow the two moving pulleys to collapse at the same time. At the second anchor, tie a figure eight on a bight in the second haul line and attach with a carabiner. Extend the

Gear needed for a pig rig:

- Two pulleys
- Three carabiners
- Two Prusik loops
- Two low stretch kernmantle ropes
- Anchor material

remaining rope of the second haul line out to the head of the system and place a turn in it. A second Prusik is now tied to the first haul line at the head of the system. A pulley is placed in the first turn and attached to the Prusik. Another pulley is placed in the second turn and attached to the figure eight in the end of the rope.

Safety Considerations

A 10:1 safety margin should always be maintained. This means that the force exerted on the system should never exceed 1:10 of the breaking strength of the line being used. For example, if a 1/2" nylon rope has a breaking strength of 9,000 lbsf, then 900lbs force should not be exceeded. The NFPA requires a 15:1 safety margin. For the same rope, 600 lbsf is the limit.

With this said, a pinned canoe in a 9 mile per hour current can have upwards of 1,500lbsf exerted upon it. It is therefore necessary to

think of a Z-drag as a means to shift the boat enough to allow the river to release it, not as a device to fight the power of the river. Catastrophic failure can occur and cause serious injury.

The Prusik hitch is the weakest point in the system, given that all other gear is in good repair. It is common for these hitches to begin to slide before they fail; however, this is not always true. If the hitch begins to slide, that is a warning to change the plan of action. We do not want to back the hitch up or use ascending devices to gain strength. We cannot overpower the river.

Safety:

1. Keep it simple: MA should not be your first choice in unpinning a boat.
2. Never try to overpower the river. Think about shifting the boat and letting the river release it.
3. NFPA requires a 15:1 safety margin. For non-agency work, a 10:1 margin is acceptable.
4. Dampen the haul line
5. Consider a change of direction at the anchor point
6. Always wear PFD, helmet
7. If it is not working, change your direction of pull. DO NOT ADD MORE MA!

When pulling on a Z-drag, it is most efficient to pull in line with the haul line. However, this can put us in harm's way if the system were to break. It is important to wear proper safety equipment: helmet and PFD. If we have the gear, a change of direction should be placed at the anchor point so that the pulling team can pull a safe distance away from the system.

The haul line should be dampened. This means that a weight should be placed on the line to dampen the kickback if the system were to break. This weight should be place as close to the object of pull as possible to stop the force from kicking back to the pull team. Pulleys and carabiners should be padded as well to protect haul team.

Tension Diagonals

The tension diagonal is a system used to cross the river in a controlled fashion. It is a fundamental of swiftwater rescue and a technician should understand how to effectively set one up.

The Basics-
A line is suspended and tensioned at an angle to the current about 1' to 4' above the river. A person holding on to a Prusik loop attached to the rope with a pulley, can then, in a controlled fashion, cross the river on the line. A rescuer can attach a rescue PFD to the prussic loop and have both hands free to transport an unresponsive or injured victim. Gear can be clipped to the line and sent across.

The Details-
The tension diagonal requires a line crossing. This can be a difficult exercise with even the most experienced crews. Pre-planning and communication are paramount.

Three common reasons line crossings fail:

1. The anchor on the weak side was not pre-set
2. Rope drag was not minimized
3. Not enough people on the weak side to attach line

It is important, in any group exercise, to establish a leader. The leader will then delegate the jobs of weak side rigger, strong side rigger, line crossing team, upstream spotter, and downstream safety.

The weak side rigger and strong side rigger should meet and discuss possible anchor points. Keep in mind that a bend in the

river or lateral current vectors may require a steeper or shallower angle of the rope.

Once anchor points have been established, the weak side rigger (with a team, if necessary) will cross the river. The anchor should be assessed and prepared. If using anchor material, the weak side rigger should now set the anchor. If using a tensionless no knot, the anchor should be prepared (clear brush or sticks that may cause issues). It is important that the weak side anchor be as close to river level as possible.

The line crossing team should now get the line across. Options for crossing a line are throwing, wading, swimming, boating, or using a line gun or arborists sling shot (not necessarily in that order). Keep in mind that rope drag should be minimized. This can be done by using a smaller diameter rope as a messenger line. If crossing by boat or swimming, have the belay team downstream of the line crosser. Also, try to keep the line out of the water. Once the line is across, it should be attached to the weak side anchor.

The line should now be tensioned on the strong side. This can be done with or without mechanical advantage. The tension of the line is dependent on the distance across the river, the angle of the line, and the speed of the current. If any one of these is miscalculated, the person crossing the line may be stranded in the middle of the river when the slack in the line creates a U, and further travel means going upstream.

Section 9
Glossary

Some terms related to hydrology are located on pages 12-14.

ABC's- *(Airway, Breathing, Circulation)* The foundation of first aid.

ACA- *(American Canoe Association)* Founded in 1880, The American Canoe Association is a national nonprofit organization serving the broader paddling public by providing education related to all aspects of paddling; stewardship support to help protect paddling environments; and sanctioning of programs and events to promote paddlesport recreation.

Allergic reactions- The body's reaction to a foreign substance. Severe allergic reactions are life threatening.

Benedryll- *(Diphenhydramine)* Antihistamine drug

Breaking wave- A large wave with a some recirculating whitewater. Often big enough to flip a raft or swamp a canoe, but rarely a danger of recirculating a swimmer.

Class I-VI- International classification system for whitewater. Class I is the easiest and Class VI is unrunnable (see page 14).

CFS- *(cubic feet per second)* The measurement of volume in the rivers. It is estimated by taking the average width of the river multiplied by the average depth of the river and divided by the speed of the river.

CPR- *(cardio-pulmonary resuscitation)* Technique developed to manually pump blood through a person in cardiac arrest.

Drowning- Death by submersion.

Eddy- An eddy is created by an obstruction in the river. Current is traveling in the opposite direction from the river.

Eddy line- An eddy line is where the eddy current and the river current meet.

Epinephrine- A medication used to simulate the effects of adrenaline. Used primarily for allergic reactions and asthma.

Heart attack- An occlusion of a coronary artery that causes death to the heart tissue.

Holes- *see Hydraulic.*

HR- *(heart rate)* Pulse rate in beats per minute. A healthy HR is 60-100 bpm.

Hydraulic- A feature created by water plunging over a rock and folding back on itself. Possible recirculation hazard.

Hyperthermia- Too much heat.

Hypothermia- Not enough heat.

ICS- *(incident command system)* Developed by wildland firefighters. ICS is a system to organize a large or small group.

LAST- *(Locate, Access, Stabilize, Transport)* The four phases of rescue.

Low head dam- A man-made hydraulic that is extremely difficult to get out of.

LOR- *(level of responsiveness)* Acronym used to describe a persons awareness.

PFD- *(personal floatation device)* A jacket worn on the water that provides floatation for a swimmer.

Pillow- Feature on the upstream side of an obstruction formed by water being pushed up and around the obstruction, oftentimes a rock.

NFPA- *(National Fire Protection Agency)* Organization charged with setting the standards for fire and rescue work in North America.

ReThRoGo- *(Reach, Throw, Row, Go)* Acronym used to describe the risk-assessment protocol for rescuing a victim from water.

Riverboard- A boogie board used on the river for recreational and rescue use. Many riverboards are specifically designed for use on the river, while others may be designed for ocean use. Typically, a specialized riverboard has a significant amount of floatation.

River left- A universally used term to describe the left-hand bank of the river with the orientation of facing downstream.

River right- A universally used term to describe the right-hand bank of the river with the orientation of facing downstream.

RR- *(respiratory rate)* Rate of breaths per minute. A healthy RR is 12-20 bpm.

Shock- A life-threatening condition created by the body's inability to deliver blood to the entire system.

Sieve- A pile of rocks that has spaces big enough for water to pass through, but not a boat or swimmer.

Strainer- An obstruction in the river, often a tree, that allows water to pass through, but not objects.

Throwbag- A bag full of rope that can be thrown to a victim in the water.

Tongue- The green water that passes through a rapid. Usually signified by a series of downstream Vs.

Trauma- Injury caused by a force acting on a body from the outside.

"**umbles**"- A group of symptoms that may indicate hypothermia: stumbles, mumbles, fumbles, and grumbles.

Undercut- An obstruction that allows water to pass below it.

Wave train- A series of waves.

Section 10
Appendices

Appendix A: First Aid Kit

There is no golden list of what should be included in any first aid kit. Your supplies will depend on your level of training, your trip duration, your activity, the number of people in your group, the location of your trip, and much more.

It is important, though, that you are familiar with the supplies that you do bring. As in swiftwater, you should be trained and practiced before you take action in a real emergency.

Below is a list that can serve as a starting point for your first aid kit.

- 4" ace bandage
- 4x4 Gauze
- Rolls of 4" Kling
- Large absorbent dressing
- Irrigation syringe
- Moleskin
- Second skin
- Tincture of benzoin
- Alcohol prep pads
- Band-Aids
- Steri-strips
- Povidine-iodine
- Telfa
- NSAIDs
- Diphenhydramine
- Sun screen
- Cavit
- SAM Splint
- Athletic tape
- Cravats
- Latex gloves
- Pencil
- SOAP notes
- Scissors
- Tweezers
- Write-in-rain paper
- Pocket mask
- Thermometer
- Duct tape
- Simple sugars
- Fire starter

Adapted from "Wilderness Medicine: 9th Edition," by Aerie Backcountry Medicine.

Appendix B: Gear List

As with first aid kits, there is no set list of gear needed on a river trip. It will be dependent upon many variables. What we have outlined below is a starting point.

Emergency Supplies
First aid kit
Tent repair kit
1 Throwbag per person
Spare paddle/oars
Raft repair kit
300' static line
4 pulleys
4 Prusiks
4 x 20' sling (1" webbing)
Sat phone/cell phone/two-way radio

Camp Supplies
Fire pan
Stove
Table
Kitchen box
Tent
Sleeping bag
Sleeping pad
Rain gear
Gloves
Beanie
Extra socks

Orientation
Guide book
Maps
Compass

Boating Supplies
Pump
PFD
Helmet
Thermal protection
Dry/wet suit

Misc
Extra batteries
Water bottle
Water treatment (filter, iodine, chlorine)
Extra fire starters (waterproof matches, lighters, flint and steel)
Camera
Sunscreen
Sunglasses
Journal
A good book

Appendix C: Safety Talk

Whether on a commercial river trip, a rescue scene, or a weekend float with friends, the safety talk is of great importance. Keep in mind that this will set the tone of the trip. The talk, however, does not have to be scary to be serious.

Below are a few ideas to include in your safety talks.

Commercial and Private Raft Trip

1. Trip overview
2. PFD fit
3. How to sit in boat
4. How to paddle
5. What to do if you fall out
6. How to get back into boat
7. Defensive/aggressive swim
8. Foot entrapments
9. Throwbags
10. Strainers
11. What to do if the boat flips

Remember that no two river trips are the same. Safety talks must be adjusted to the conditions of the day. Also, keep in mind that a good trip leader is always reinforcing safety, and clarifying the specifics once on the river.

Rescue Operations

1. Scene overview
2. Designate hot/warm/cold zones
3. Delegate ICS positions
4. Gear allocation
5. PFD fit (buddy check)
6. Safe eddy location
7. Downstream safety
8. Upstream spotter
9. Back-up plans

Remember that the river is a dynamic environment and even the best plans usually do not work. It is important to be flexible and allow for variations. As long as everyone is following the basic rules of river rescue, then it is a good rescue.

Appendix D: Resources

Ammons, Doug. ***Whitewater Philosophy***. Missoula, Montana: Water Nymph Press, 2009

Bechdel, Les, and Slim Ray, ***River Rescue, 4th Edition***. Asheville, North Carolina: CFS Press, 2009

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Ray, Slim. ***Swiftwater Rescue***. Asheville, North Carolina: CFS Press, 2005

Smith, Bruce, and Allen Padgett, ***On Rope: North American Vertical Rope Techniques***, Huntsville, Alabama: National Speleological Society, 1996

Walbridge, Charles, and Wayne A. Sundmacher, Sr., ***Whitewater Rescue Manual: New Techniques for Canoeists, Kayakers, and Rafters***, Camden, Maine: Ragged Mountain Press, 1995

NOTES

Swiftwater Rescue

The Whitewater Rescue Institute offers students more than a certification. We offer over 40 years of combined experience in swiftwater education. Students walk away from our courses with more than knowledge. We teach through scenarios. What this means is that when students leave the class, they will have a comprehensive understanding of what works and what does not in swiftwater rescue. Through the scenarios students will get real, hands-on experience in swiftwater rescue. This manual is an integral part of WRI swiftwater rescue training.

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